QUALITY OF DEHYDRATED LIMA BEANS AS INFLUENCED BY PROCESSING VARIABLES AND STORAGE TEMPERATURE

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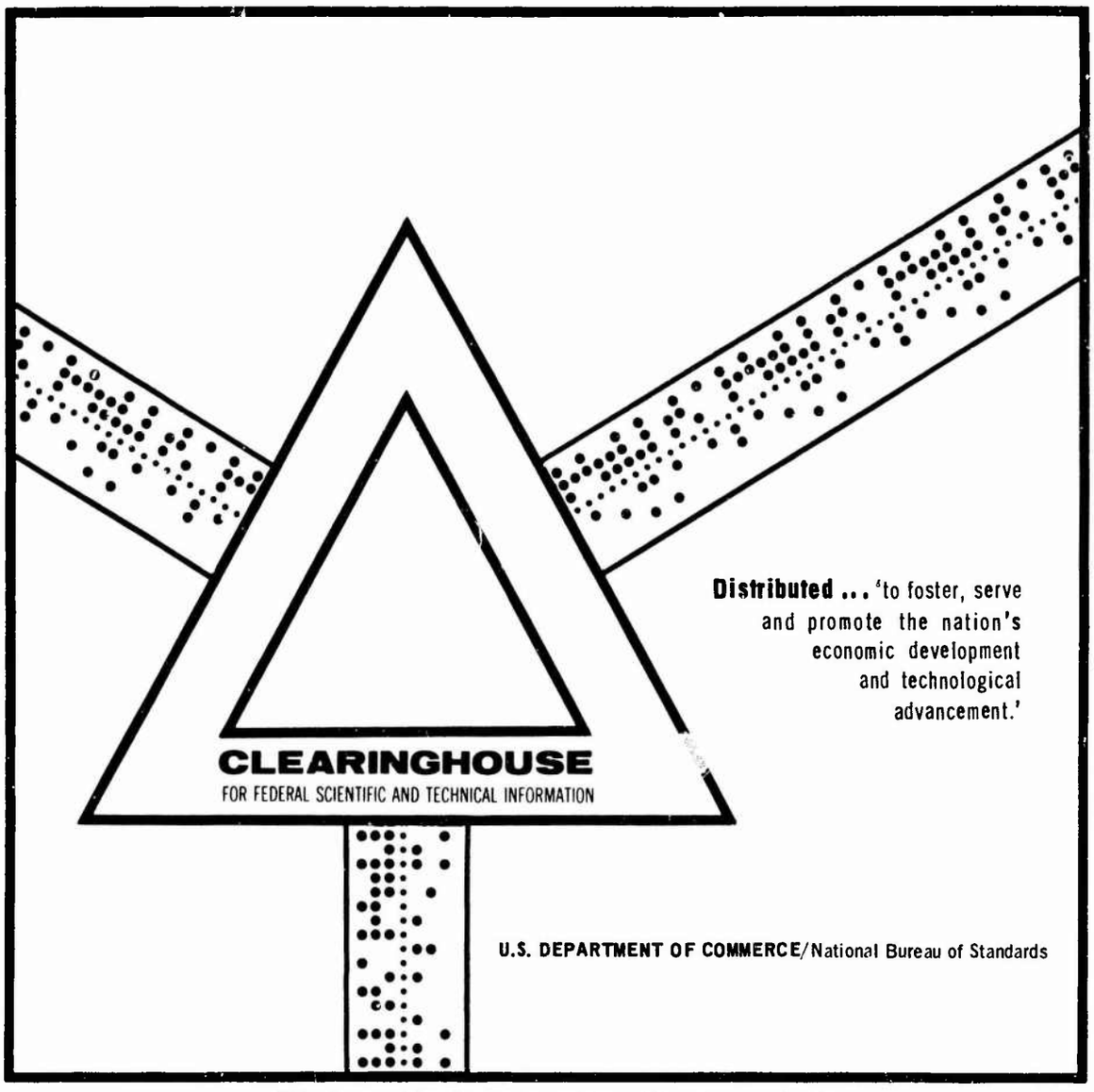
Army Natick Laboratories
Natick, Massachusetts

November 1969



TECHNICAL REPORT
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Food Laboratory
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QUALITY OF DEHYDRATED LIMA BEANS AS INFLUENCED BY PROCESSING VARIABLES AND STORAGE TEMPERATURE

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Foreword

The impact of radical new weapons on organizational, tactical, and logistical planning demands that new concepts of military feeding be implemented. Dehydrated foods currently used in military rations offer significant savings in storage and transportation requirements. However, such foods require trained food service personnel as well as special serving equipment for their preparation. Therefore, precooked dehydrated foods which can be prepared simply by the addition of hot water appear to offer many conveniences needed by the highly mobilized armed forces.

This work was undertaken to determine the effect of processing procedures such as blanching, freezing and dehydration on the flavor and texture of rehydrated lima beans. The results obtained from this study will be utilized in the development of additional items for the 25-Man Uncooked Meals, Quick Serve Meals and other combat rations as well as in the improvement of existing rations.

This work was conducted under project No. 1J6-62708-D553, Food Processing and Preservation Techniques.

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ABSTRACT

The effect of blanching time, sulfiting and freezing prior to dehydration on the quality of rehydrated lima beans after 6 months storage at 40°, 70°, and 100°F. were investigated. The results indicate that blanching time directly affected the quality whereas freezing prior to dehydration did not exhibit any beneficial effect concerning rehydration ratio, flavor or texture. Storage at 100°F. for 6 months adversely affected the quality of lima beans regardless of the treatments.

QUALITY OF DEHYDRATED LIMA BEANS AS INFLUENCED BY PROCESSING VARIABLES AND STORAGE TEMPERATURE

Introduction

Undesirable flavor and textural changes were revealed during U.S. Army Natick Laboratories acceptance evaluation of commercially procured, precooked dehydrated lima beans which had been stored for various lengths of time at various temperatures (i.e., up to 6 months and up to 100°F.). Some of the flavor changes which occurred during storage were characterized by industry and NLABS investigators as fishy, hexanol, castor or linseed oil-like in flavor. These changes might be associated with inadequate lipoxidase inactivation and other processing, packaging, and storage variables. With the limited number of dehydrated vegetable products currently in the military ration system it was necessary to investigate the causes of the development of off-flavors and textural changes to upgrade the overall acceptability of dehydrated lima beans.

Review of Literature

Attempts had been made by many researchers to study the quality of rehydrated lima beans as affected by oxidative enzymes, processing techniques and storage time and temperature. Dillard et al. (1961) reported that at least two lipoxidases exist in legumes, one specific for linoleic acid or other fatty acids with methylene - separated dieneic system, and the other for glycerol esters of these fatty acids. Nelsen and Steinberg (1956) indicated that when lima beans are artificially dried, they often split and sometimes crack or curl. Usually the skin splits, the cotyledons curl outward at one end, and the bean assumes the appearance of a Y. This curling or distorting is very noticeable in the dehydrated product. However, when the beans are rehydrated, the product assumes a normal shape and the damaged beans are not readily apparent. Brown et al. (1952) employed several methods of dehydration and found that blanching followed by freezing prior to dehydration exhibited the most satisfactory results. They also indicated that no technique was discovered which prevented the separation of the cotyledons and subsequent cracking. However, upon rehydration the halves usually unite so that this was not as serious a defect as might appear from an examination of the dried beans.

Numerous processing techniques were developed to produce acceptable precooked lima beans. Feldberg et al. (1956) reported that acceptable precooked dehydrated beans were prepared by soaking for at least 8 hours followed by steam pressure cooking at 245°F., 13 p.s.i. for 20 minutes; the cooked beans were then frozen and dehydrated at either 170°F. dry bulb for 1-1/2 or 1-1/4 hours, respectively. Heff and Nelson (1965) indicated that the rate of water uptake in dry pea beans was increased when absorbed or trapped gasses were released from the surfaces of beans by steam pressure, vacuum or sonic energy treatments. Burr et al. (1965) found that high temperature, high moisture content, and long storage contributed in impaired cooking quality ability in pinto, large lima, and Sanilac* beans. Rockland and Metzler (1967) indicated that quick-cooking lima beans have been developed by 1) alternating vacuum and pressure treatment of beans for 30 minutes in solution containing inorganic salts; 2) soaking for 4 to 5 hours in the solution; 3) rinsing, and 4) drying.

* A pea bean variety.

Experimental Procedures

Fresh lima beans of the Thorogreen variety were purchased from a local market, dehulled and processed at a commercial processing plant. The beans were divided into 3 lots, and then blanched in water at 210°F. for 10, 15 and 20 minutes, respectively. Half the lima beans in each blanched lot were sulfited by spraying with solution of sodium bisulfite to yield approximately 750 ppm SO_2. Half of each of the sulfited and non-sulfited lots were frozen at -20°F. All the resulting lots were then dehydrated by a conventional air dryer with the following temperature cycle: 170°F. for 30 minutes, 150°F. for 90 minutes, and 125°F. for 60 minutes. Drying was finished in a bin drier at 120°F. for 24 hours. The dehydrated lima beans were then packaged in No. 2-1/2 tin cans under N_2. Representative samples of each variable were stored at 40°F., 70°., and 100°F. for a period of 6 months. Technological panel evaluations for flavor and texture were conducted by 10 trained judges using a 9-point scale (1 = extremely poor; 9 = excellent). The dehydrated lima beans were rehydrated by placing them in boiling water (approximately 4/1 ratio water to lima beans by weight) and allowing to stand for 12 minutes in a covered pan. Additional heat was not applied. Rehydration ratio was determined by dividing the rehydrated weight of the lima beans by the dry weight. Texture of rehydrated lima beans was measured on a Lee-Kramer shear press using the 5000-pound ring with 30 seconds downstroke.

Results and Discussion

Results shown in Table 1 and Figure 1 indicate that storage temperature significantly affected the texture regardless of the treatments. Lima beans stored at 100°F. exhibited tougher texture than these stored at 40°F. or 70°F. However, lima beans blanched for ten minutes and frozen before dehydration exhibited the toughest texture as measured by the shear press at all storage conditions. The technological panel detected this difference only in lima beans stored for 6 months at 100°F. A significant correlation coefficient of .83 was found between the technological panel scores and the shear press force expressed in pounds for lima beans stored for 6 months at 100°F.

Results shown in Table 2 indicate that flavor of rehydrated lima beans was significantly affected by treatments as well as by storage temperature. Lima beans stored at 100°F. received lower scores than the initial. However, such differences were not significant in lima beans blanched for 15 minutes, sulfited, not frozen or blanched for 20 minutes, not sulfited, not frozen.

Results shown in Table 3 indicate that the rehydration ratio was significantly affected by treatments regardless of the storage temperature. Lima beans that received 20 minutes blanching exhibited a higher rehydration ratio than those blanched for 10 minutes. However, the rehydration ratio was not affected by storage temperature. This indicates that rehydration ratios did not affect the texture or the flavor of the lima beans.

A visual examination indicated no noticeable physical changes due to the various treatments. Statistical analysis of the data indicate that freezing prior to dehydration did not improve the visual appearance, rehydration ratio, flavor or texture of the product. However, blanching time appears to be the most critical factor affecting the quality of dehydrated lima beans. A 10-minute blanching adversely affected the quality of the limabeans. Therefore, a longer period is recommended. In addition the flavor of sulfited lima beans received higher ratings but not significant than the unsulfited ones regardless of the storage temperature.

Conclusions

Lima beans should be blanched for a period longer than 10 minutes before dehydration to achieve an acceptable quality finished product. Freezing the lima beans before dehydration did not improve the quality of the finished product. Therefore, it is not recommended.

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Table 1. Effect of Processing Treatments and Storage Temperature on Texture of Rehydrated Lima Beans

Treatments	Initial		6 Months Storage					
			*40°F.		*70°F.		*100°F.	
	Aver. Score 1/	Lbs. 2/	Aver. Score	Lbs.	Aver. Score	Lbs.	Aver. Score	Lbs.
1. 10 min. blanching, sulfited, frozen	4.9	235	4.9	340	5.2	350	3.0	435
2. 10 min. blanching, sulfited, not frozen	5.4	237	4.9	228	4.5	280	3.7	312
3. 10 min. blanching, not sulfited, frozen	5.9	277	4.5	430	5.3	375	2.7	540
4. 10 min. blanching, not sulfited, not frozen	5.3	245	4.6	300	5.2	312	3.4	312
5. 15 min. blanching, sulfited, frozen	5.6	282	5.2	262	5.3	292	3.5	375
6. 15 min. blanching, sulfited, not frozen	5.4	265	5.2	257	5.3	280	4.4	312
7. 15 min. blanching, not sulfited, frozen	5.6	242	5.3	297	5.3	282	4.1	312
8. 15 min. blanching, not sulfited, not frozen	5.2	255	4.8	307	5.2	312	4.3	312
9. 20 min. blanching, sulfited, frozen	5.7	245	5.2	270	5.4	282	3.8	305
10. 20 min. blanching, sulfited, not frozen	5.3	262	4.9	285	4.9	280	4.9	267
11. 20 min. blanching, not sulfited, frozen	6.1	235	4.8	285	5.3	282	3.9	280
12. 20 min. blanching, not sulfited, not frozen	5.5	252	4.8	312	5.3	312	4.9	265

* 1. Technological panel
* 2. Lee-Kramer shear press

* No significant difference at the 5% level

Table 2. Effect of Processing Treatment and Storage Temperature on Flavor of Rehydrated Lima Beans

Treatment	Initial	Technological Panel Rating (Average) 6 Months Storage		
		40°F.	70°F.	*100°F.
1. 10 min. blanching, sulfited, frozen	5.7	4.8	5.5	4.3
2. 10 min. blanching, sulfited, not frozen	5.6	5.3	5.6	4.5
3. 10 min. blanching, not sulfited, frozen	5.4	4.8	5.5	3.6
4. 10 min. blanching, not sulfited, not frozen	5.9	4.3	5.4	4.1
5. 15 min. blanching, sulfited, frozen	6.0	5.3	5.7	5.2
6. 15 min. blanching, sulfited, not frozen	5.7	5.5	5.9	5.6
7. 15 min. blanching, not sulfited, frozen	6.1	5.3	5.6	4.4
8. 15 min. blanching, not sulfited, not frozen	5.6	4.6	5.3	4.3
9. 20 min. blanching, sulfited, frozen	6.2	5.7	5.6	4.1
10. 20 min. blanching, sulfited, not frozen	5.9	5.3	5.1	5.3
11. 20 min. blanching, not sulfited, frozen	5.2	4.5	4.8	4.0
12. 20 min. blanching, not sulfited, not frozen	5.3	5.0	5.0	5.0

* No significant difference at the 5% level

Table 3. Effect of Processing Treatments and Storage Temperature on Rehydration Ratios $\frac{\text{(Rehydrated weight)}}{\text{(Dry weight)}}$ of Dehydrated Lima Beans

Treatments	Initial	Rehydration Ratios Storage Temperature		
		*40°F.	*70°F.	*100°F.
1. 10 min. blanching, sulfited, frozen	3.0	2.8	2.9	2.9
2. 10 min. blanching, sulfited, not frozen	3.2	3.2	2.9	3.0
3. 10 min. blanching, not sulfited, frozen	3.0	2.9	3.1	2.9
4. 10 min. blanching, not sulfited, not frozen	3.1	3.1	3.1	2.9
5. 15 min. blanching, sulfited, frozen	3.2	3.1	3.1	2.9
6. 15 min. blanching, sulfited, not frozen	3.1	3.1	3.2	3.2
7. 15 min. blanching, not sulfited, frozen	3.2	3.2	3.2	3.1
8. 15 min. blanching, not sulfited, not frozen	3.3	3.2	3.1	3.2
9. 20 min. blanching, sulfited, frozen	3.2	3.2	3.1	3.2
10. 20 min. blanching, sulfited, not frozen	3.1	3.4	3.2	3.4
11. 20 min. blanching, not sulfited, frozen	3.3	3.3	3.3	3.2
12. 20 min. blanching, not sulfited	3.4	3.3	3.3	3.3

* No significant difference at the 5% level.

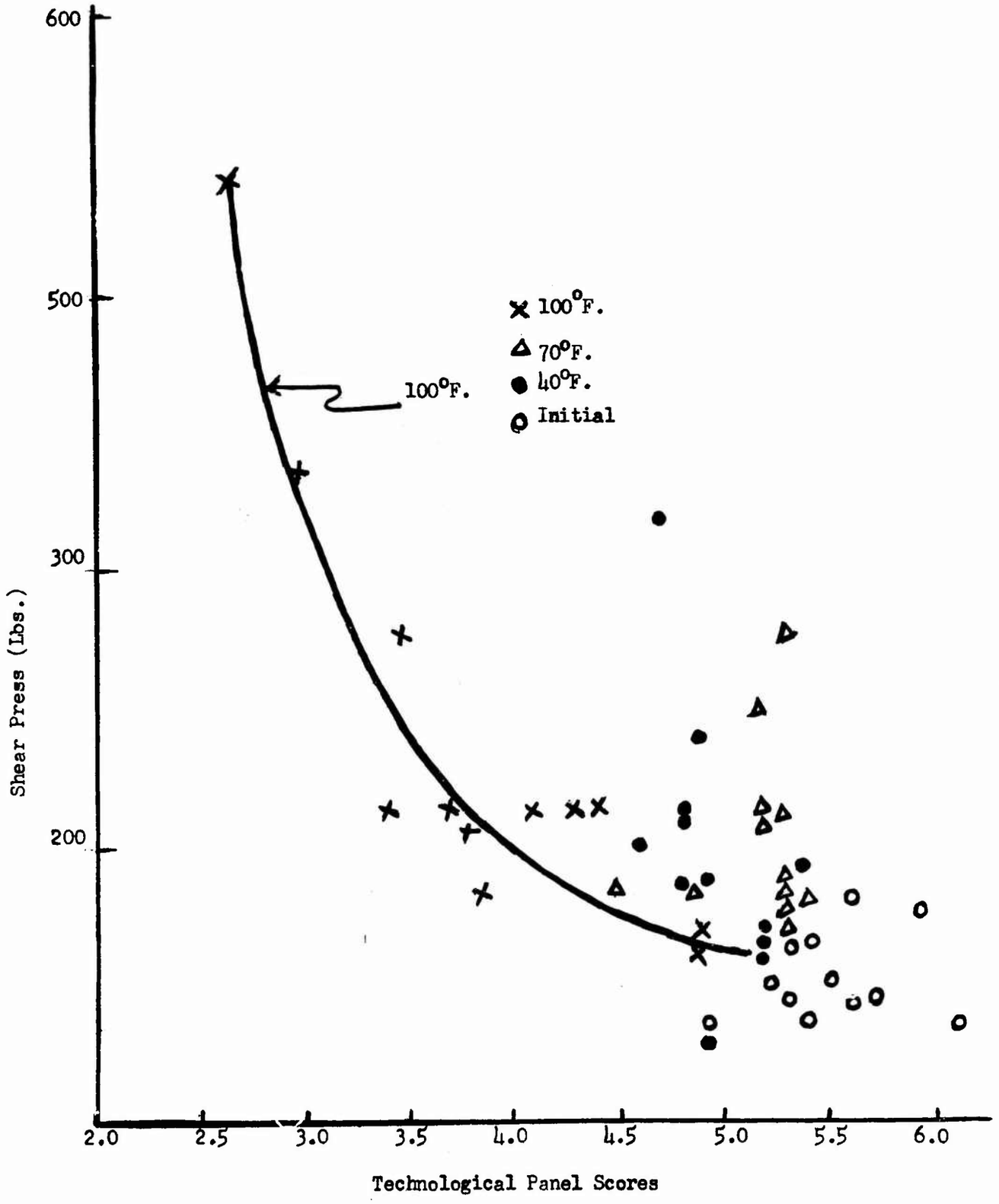

Figure 1 - Correlation of Technological Panel Scores with Shear Press values for Texture of Rehydrated Lima Beans after Storage of 6 months at 40°., 70°., and 100°F.

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13. ABSTRACT

The effect of blanching time, sulfiting and freezing prior to dehydration on the quality of rehydrated lima beans after 6 months storage at 40°, 70°, and 100°F. were investigated. The results indicate that blanching time directly affected the quality whereas freezing prior to dehydration did not exhibit any beneficial effect concerning rehydration ratio, flavor or texture. Storage at 100°F. for 6 months adversely affected the quality of lima beans regardless of the treatments.

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Time	6		6			
Blanching	6		6			
Sulfiting	6					
Freezing	6		6			
Lima Beans	7		7			
Dried foods			7			
Dehydration	7					
Rehydration			7			
Flavor			7			
Texture			7			
Storage			6			